AD NUMBER

ADB009730

LIMITATION CHANGES

TO:

Approved for public release; distribution is unlimited.

FROM:

Distribution authorized to U.S. Gov't. agencies only; Test and Evaluation; FEB 1976. Other requests shall be referred to Army Materiel Development and Readiness Command, Attn: DRCSF-S, Alexandria, VA 22333.

AUTHORITY

usamdrc ltr, 26 may 1976

AD

RDTE PROJECT NO./FSN _____
TECOM PROJECT NO. 9-CO-150-000-030
REPORT NO. APG-MT-4764
TEST SPONSOR US ARMY MATERIEL DEVELOPMENT AND READINESS COMMAND
TEST SPONSOR PROJECT NO. NOT AVAILABLE
TRADOC AC NO. NOT AVAILABLE

See 1473

SPECIAL STUDY OF GUNNERY PRACTICE USING TARGETS TOWED BY MANNED AIRCRAFT

FINAL LETTER REPORT

BY

MAJOR LARRY D. BRUGH

FEBRUARY 1976

US ARMY ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND

REPRODUCTION LIMITATIONS

Reproduction of this document in whole or in part is prohibited except with the permission of Commander, US Army Materiel Development and Readiness Command, ATTN: DRCSF-S

DDC is authorized to reproduce this document for United States Government purposes.

DISPOSITION INSTRUCTIONS

Destroy this report in accordance with appropriate regulations when no longer needed. Do not return it to the originator.

DISCLAIMER

The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents issued and approved by the Department of the Army.

DEPARTMENT OF THE ARMY
U S ARMY ABERDEEN PROVING GROUND
ABERDEEN PROVING GROUND, MARYLAND 21005

Maj Brugh/alt/283-3393

9 MAR 1976

STEAP-MT-I

SUBJECT: Final Letter Report of Special Study of Gunnery Practice Using Targets Towed by Manned Aircraft; TECOM Project No. 9-CO-150-000-030, Report No. APG-MT-4764

Distribution limited to U.S. Gov't. agencies only; Test and Evaluation; Feb 76. Other requests for this document must be referred to

Commander
US Army Materiel Development and Readiness Command
ATTN: DRCSF-S ([redacted])
5001 Eisenhower Avenue
Alexandria, Virginia 22333

1. REFERENCES

a. Letter, AMCSF-S, AMC, 23 July 1975, subject as above.

b. Customer Test Directive, AMSTE-TO-O, TECOM, 14 October 1975, subject as above.

c. AR 385-63, Regulations for Firing Ammunition for Training, Target Practice, and Combat, 1 May 1973.

d. Letter, AMSTE-ST, TECOM, 31 July 1974, subject: Aerial Gunnery Practice Using Targets Towed by Manned Aircraft, w/1st Ind, STEAP-MT-M, 6 August 1974.

e. Memorandum for Record, AMCSF-E, AMC, 21 June 1974, Anti-Aircraft Firing at Targets Towed by Manned Aircraft.

f. Letter, AMXBR-EB, USABRL, 6 August 1974, subject: Comments on Updated AR 385-63.

g. 1st Ind to reference 1e, AMST-ST, 26 August 1974.

h. 1st Ind to reference 1e, AEAGD-MM, 28 August 1974.

i. DA Form 2028, ATPR-PD-S, Regulations for Firing Ammunition for Training, Target Practice and Combat, 4 September 1974.

2. BACKGROUND

a. Reference 1a disclosed that the Commanders of TRADOC and FORSCOM have both expressed a requirement for conducting gunnery practice using targets towed by manned aircraft. The latest version of AR 385-63, reference 1c, prohibits such firing and up-to-date information on precautionary measures to be taken and risks inherent in such training operations was not available. Therefore, it was requested that TECOM formulate such guidance in a format suitable for inclusion in the referenced regulation. The Materiel Testing Directorate (MTD) was assigned the study because of the experience and information available from testing the Vulcan and other air defense systems.

b. Earlier, this and other agencies were requested to comment on a proposed change to AR 385-63, based upon a modified version of the regulation dated 1955, which allowed firing at towed targets. Due to the various comments received, the AMC Safety Office decided to request a special study by TECOM.

c. The following requirements were imposed for the study:

(1) Air defense systems to be used:

(a) Vulcan.

(b) M42, twin, 40-mm.

(c) M45, quad, cal .50.

(2) Type of ammunition:

(a) Ball.

(b) TP-T.

(c) HE.

(3) Target Speed, Range and Elevation:

(a) Speed: 200-450 KTAS.

(b) Range: 500-1500 meters.

(c) Altitude: 150-500 meters.

d. This study was conducted at the MTD, Aberdeen Proving Ground, Maryland, between October 1975 and February 1976.

3. OBJECTIVES

a. To recommend changes to AR 385-63 which will allow gunnery practice on targets towed by manned aircraft.

b. To update the surface danger zone for various ammunition when firing gun air defense systems at aerial targets and also when used in a ground support role.

4. SUMMARY OF RESULTS

a. Discussion of Results.

(1) The results of this study were based upon evaluation of references 1e through 1i, recommendations by the US Army Air Defense Board, suggestions by several divisions within the MTD, and the author's experience with three air defense system tests conducted at Fort Bliss, Texas.

(2) The requirements imposed (para 2c above) for the study (primarily maximum range of 1500 meters) virtually eliminated any procedure of safe leads as a function of towline lengths from being considered. The short times-of-flight (less than 5 seconds) involved makes such a procedure impractical.

(3) An even more practical consideration for determining safe firing conditions is that which has been imposed by the pilots (US Navy and New Mexico National Guard) who have towed targets during testing. This condition is the same as that of para 6-1b, AR 385-63 (i.e., no weapon will be fired when it is pointing at or ahead of the towing aircraft). Under field conditions, it is difficult for the safety officer (SO) to determine if the gunline is pointing at or ahead of the towing target, let alone to estimate fractions of towline lengths for safe leads.

(4) An even more restrictive condition is imposed (see para 15-4j, inclosure 1) for certain type of flight paths. This condition is necessary when ranges are short and times-of-flight are small (e.g., allowing firing when a weapon is pointed at a towing aircraft at 400 meters range would entail a very small margin of safety).

(5) This and other test agencies fabricate firing interrupt switches as required. However, these devices are not standarized and testing agencies have greater latitude in such matters than troop units in a training situation. Without further guidance, this agency cannot make specific hardware modification recommendations.

(6) The surface danger zone information (table 15-1, figures 15-1 and 15-2, AR 385-63) was reviewed and updated for the air defense systems considered. The recommended table 15-1 (inclosure 1) is applicable for both ground and aerial firing. Consideration has been given to ricochets and fragments from HE and self-destructing ammunition.

b. Results.

(1) The recommended firing procedures and surface danger zone information have been incorporated in a new chapter 15 to AR 385-63 and is attached as inclosure 1.

(2) A general discussion of safety interrupt switches is contained in inclosure 2.

(3) A discussion of possible SO locations such that he may determine the gun pointing direction is contained in inclosure 3.

5. CONCLUSIONS

It is concluded that:

a. The recommended changes to AR 385-63 will insure safe firing conditions during gunnery practice on targets towed by manned aircraft if adequate safety interrupt switches can be obtained.

b. The updated surface danger zone information will insure safe firing conditions for both aerial and ground target firing.

6. RECOMMENDATIONS

It is recommended that:

a. The updated surface danger zone information be incorporated immediately in a change to AR 385-63.

b. A program be initiated for developing standardized firing interrupt switches. These devices could be provided to troop units or perhaps more appropriately to range support personnel at the locations which can support the gunnery practice.

STEAP-MT-I
SUBJECT: Final Letter Report of Special Study of Gunnery Practice Using Targets Towed by Manned Aircraft; TECOM Project No. 9-CO-150-000-030, Report No. APG-MT-4764

c. The above mentioned feature be incorporated in any new air defense system being developed (i.e., Army Radar Gun Air Defense System, ARGADS).

d. Gunnery practice on targets towed by manned aircraft not be allowed until the conditions of paragraph b above are satisfied.

FOR THE COMMANDER:

Billy D Sissom

BILLY D. SISSOM
Associate Director
Materiel Testing Directorate

4 Incl
1. Charter 15, Air Defense Weapons (Recommended)
2. Safety Interrupt Switches
3. Safety Officer Locations
4. Report Documentation Page

Copies furnished:	No. of Copies
Cdr, DARCOM, Alexandria, VA 22333	
ATTN: DRCSF-S	15
Cdr, TECOM, APG, MD 21005	
ATTN: DRSTE-ST	2
DRSTE-TO	2
Cdr, ARMCOM, Rock Island, IL 61202	
ATTN: DRCPM-ARGADS	1
Dir, USABRL, APG, MD 21005	
ATTN: DRXBR-XA-LB	2
Cdr, APG, APG, MD 21005	
ATTN: STEAP-MT-I	4
STEAP-MT-X	1
STEAP-MT-G	1
STEAP-MT-O	1
STEAP-SA	1
Cdr, DDC, Alexandria, VA 22314	
ATTN: Docu Svc Ctr	2

Secondary distribution is controlled by US Army Materiel Development and Readiness Command, ATTN: DRCSF-S.

CHAPTER 15

AIR DEFENSE WEAPONS
(RECOMMENDED)

15-1. General. This chapter pertains to air defense automatic weapons (i.e., Vulcan, M163, M167; M42, twin, 40-mm; M45, quad, cal .50) in their use against aerial targets and in a ground support role. When used in a ground support role, the guidance outlined in chapter 17 will also be observed.

a. Air defense conventional and automatic weapons, fired in the ground support role, will be fired on ranges in accordance with figure 15-2.

b. Troops shall not be located within the surface danger zone while firing at aerial targets.

c. Personnel required to be in the surface danger zone at points other than at the battery positions will be provided with minimum overhead cover as prescribed in FM 5-15.

d. The surface danger zone will be based on the full projectile trajectory to ground; that is, no reduction of the surface danger zone will be employed to allow for self-destruction of ammunition or function of ammunition on the aerial target.

e. The dimensions of the impact area are dependent upon the nature of planned firing. In no event should the dimensions of the impact area be smaller than 5° beyond each side of the right and left limit of fire. The minimum dimensions of the impact area are based on standard conditions. No provision is made for errors which can be caused by nonstandard conditions or gross errors in laying the weapons.

f. The surface danger zone for firing at aerial targets (figure 15-1) does not provide for impacts resulting from loss of target missile control or erratic flight of a damaged target missile.

g. A safety officer must be designated by the using unit to insure compliance with all safety regulations.

15-2. Specific.

a. Target courses (registration or firing of check rounds) will not be fired during troop demonstrations or at any time when spectators are present. This restriction is applicable only to registration firing.

b. All weapons firing at aerial targets will be on a single firing line at predesignated firing positions with field of fire, troop location, and range limitations, as applicable, properly identified and marked with visible indicators.

c. Only one course will be fired at one time within the surface danger zone established for the weapon involved.

d. The quadrant elevation of any firing will not exceed 65°.

e. All personnel, except those on the firing weapon, the OIC, and safety personnel, will remain a minimum of 65 meters behind the firing line. All vehicles except firing units on the firing line will be moved to a designated area at least 65 meters behind the firing line.

f. The surface danger zone for firing at aerial targets is shown in table 15-1 and figure 15-1.

g. The surface danger zone for firing air defense weapons in a ground support role is shown in table 15-1 and figure 15-2.

h. The limits of fire for each weapon will be staked and the assigned safety office or range officer will assure that no firing is conducted outside these limits.

15-3. Target missiles.

a. Flight patterns and pertinent data on new target missiles will be determined prior to flight.

b. Targets will be launched in a direction leading away from roads, highways, and railways in the immediate vicinity whenever possible. Targets will not be flown closer than 500 meters horizontal distance from public traffic routes.

c. Flights normally should be conducted only during daylight hours. In the event that flights must be conducted between sunset and sunrise, anticollison lights (Grimes lights) and red and green navigation lights are required. All lights must be properly located in accordance with standard aircraft lighting requirements. Failure of any of the lights after launch will be cause for immediate recovery of the aerial target.

d. A warning system will be established to warn personnel in event of loss of target control.

e. All aerial target flights will be contained within the restricted airspace assigned to the installation. Exceptions must be coordinated with the Federal Aviation Administration at least 90 days prior to occurrence.

f. Radar surveillance of restricted airspace used for aerial target flights is required. Exceptions to this requirement are permitted only when aerial targets are flown within sight of the target controller. In this case, a minimum of two air observers, provided with a means of communicating directly with the target controller, will be posted to observe for manned aircraft penetration of the airspace concerned.

g. For the radio-controlled aerial target (RCAT) MQM33, the safety requirements given in the applicable TM and FM will also apply.

h. For the ballistic aerial target system (BATS), the safety and surface danger zone requirements established in chapter 6 will be followed.

i. When target control is lost, the controller will immediately report the loss of control to the OIC and SO. The air guards will note the last position of the target missile. Depending on location of the last position of the target missile, applicable agencies having control of the surface or included ground impact area will be notified. The range control office will notify the agency responsible for control of forest fires and institute recovery procedures.

15-4. Towed targets. When using targets towed by manned aircraft, the following requirements are in addition to those of chapter 6 and the preceding paragraphs of chapter 15.

a. Only one weapon system will be allowed to fire during a target pass (see para 15-2e).

b. The SO will position himself such that he can determine the gunline (i.e., extended centerline of the firing barrel(s)) at all times.

c. The SO will be in direct communication with the gunner at all times.

d. The SO will have a safety switch which will allow him to prevent and interrupt firing.

e. Only straight-line, constant velocity, constant altitude courses may be flown.

f. Only crossing type courses may be flown, with a minimum crossover or offset range of 250 meters (i.e., the ground track of the flight path will not be less than 250 meters at the point of closest approach to the firing weapon system, see figure 15-3).

g. The minimum towline length will be 1000 meters. Preferably the towline length will be 1200 to 1800 meters.

h. Local range safety regulations will apply, but generally, the towed target will be tracked at all times by an instrumentation radar, with the target position relative to the firing weapon indicated on a plotting board. The flight path and target speed will be controlled by personnel located at the plotting board via ground-to-air communication.

i. A chase plane will be provided which will visually check the target after each firing pass and at any other time as requested by the pilot of the towing aircraft. The decision authority as to whether or not a towed target will be dropped due to an unstable target or any other suspected unsafe condition lies solely with the pilots of the towing and chase aircraft, not with the OIC of the firing exercise.

j. When firing at targets with a ground offset range (see figure 15-3) of 400 meters or less, the only safe firing interval shall be from the time the towing aircraft is at crossover until the towed target reaches crossover. At all times the condition of paragraph 6-1b will be met (i.e., no weapon will be fired when it is pointing at or ahead of the towing aircraft).

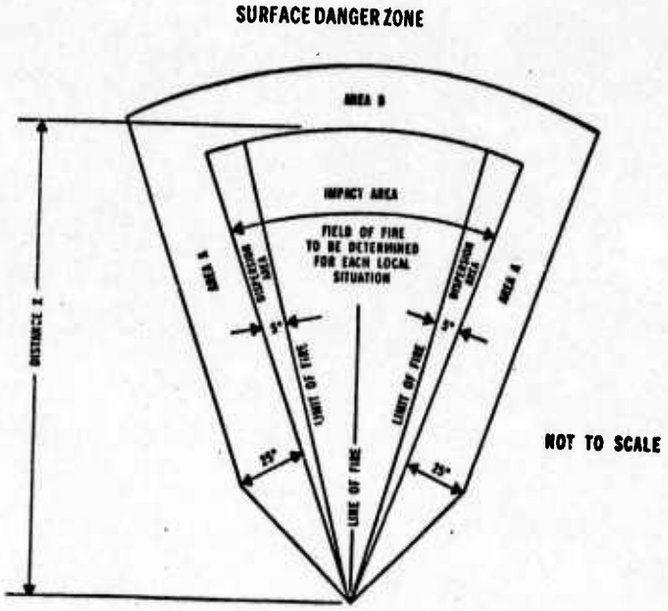

Figure 15-1. For weapons firing at aerial targets (see table 15-1).

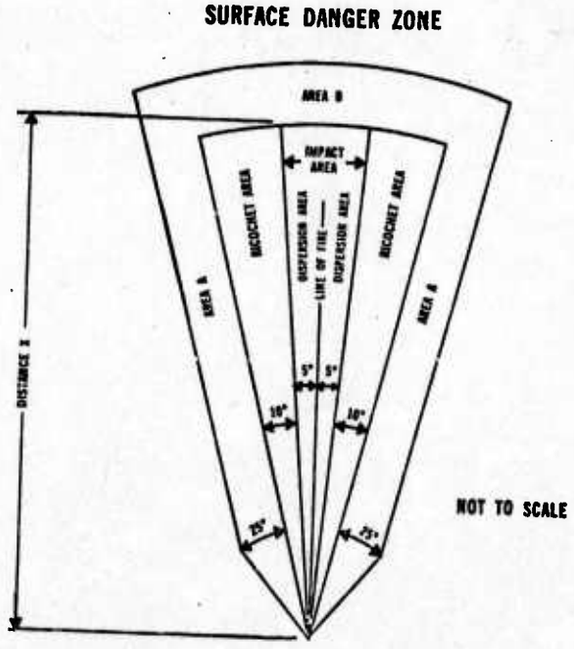

Figure 15-2. For air defense weapons firing at ground targets in a ground support role (see table 15-1).

Table 15-1. Antiaircraft Weapons (See Figures 15-1 and 15-2)

Caliber	Dimensions of areas in meters A[1]	B[1]	C[2]	Distance X
.50	250	300	300	6500
20-mm	400	500	600	4200
40-mm	400	500	600	9800

[1]Width of indicated area.
[2]Distance in this column represent minimum aerial target engagement distances when personnel at the firing position are unprotected.

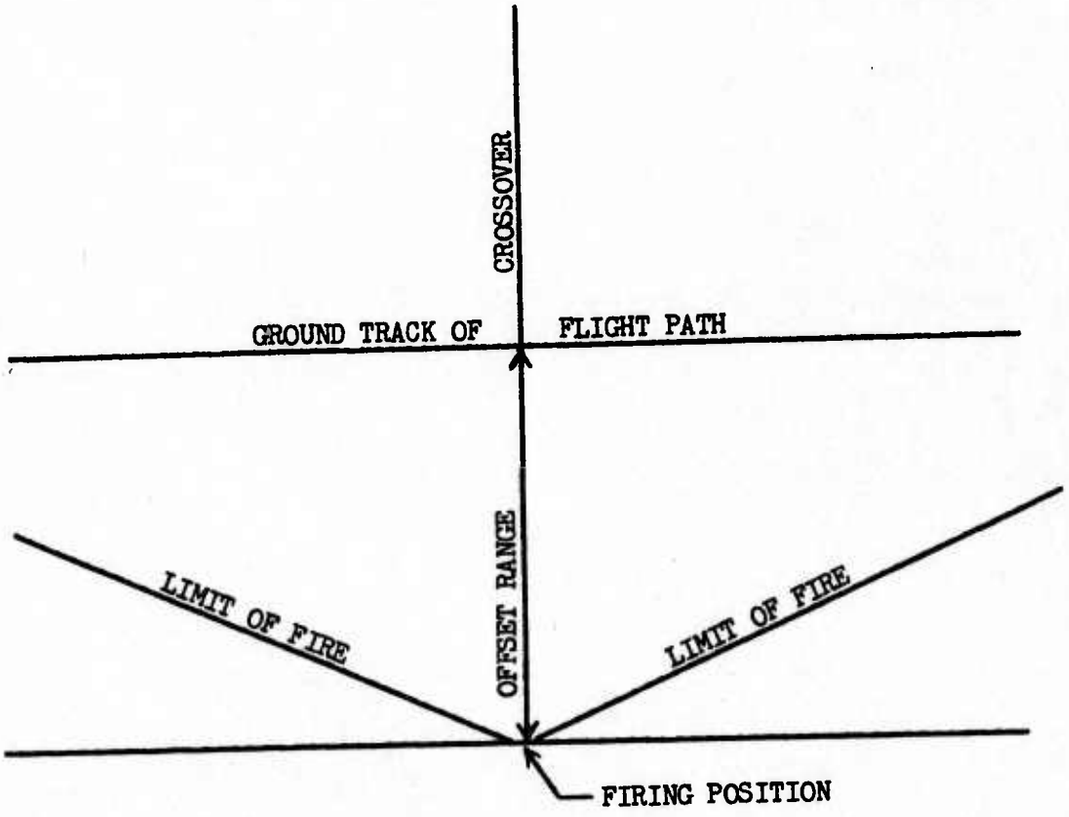

Figure 15-3. Description of crossover.

SAFETY INTERRUPT SWITCHES

1. Vulcan, M163, M167 Systems. The firing interrupt switch can be inserted into the firing contact assembly located on the gun housing. This will prevent initiation of the electrically primed ammunition even though rounds may still be conveyed through the gun.

2. M45, Quad, Cal. 50. The firing interrupt switch can be inserted in the firing circuit switch located on the firing control handle. The cal .50 guns are internally powered (recoil operated) and fire percussion-primed ammunition. In the event that uncontrolled fire occurs with the M45 system, firing may not be stopped even though all electrical safety devices have been applied. This was not investigated further.

3. M42, Twin, 40-MM. The firing interrupt switch can be inserted in the firing circuit on the gun controller hand grip. To prevent firing mechanically, the manual firing mechanism must be disconnected from the foot pedal shaft.

Inclosure 2

(Following Page Blank)

SAFETY OFFICER LOCATIONS

1. Vulcan, M163. On the rear deck of the vehicle or physically riding on the rear of the turret behind the gunner.

2. Vulcan, M167. On the ground, between the trails of the carriage.

3. M45, Quad, Cal. 50. Location is dependent on the type of conveyance to which the gun mount is installed (i.e., vehicle, gun carriage, or trailer). Generally the SO's location would be on the ground, behind the guns and conveyance.

4. M42, Twin, 40-MM. On the turret directly behind the guns. However, to do this, a platform or seat would have to be attached to the turret. A platform could be constructed on the ground and available at the firing range.

Inclosure 3

(Following Page Blank)

REPORT DOCUMENTATION PAGE

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: USA TECOM [redacted]-9-CO-150-000-030	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Special Study of Gunnery Practice Using Targets Towed by Manned Aircraft.	5. TYPE OF REPORT & PERIOD COVERED: Final Letter Report, 17 Dec 1975 - 20 Feb 1976.
	6. PERFORMING ORG. REPORT NUMBER: APG-MT-4764
7. AUTHOR(s): Major Larry D. Brugh	8. CONTRACT OR GRANT NUMBER(s): None
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Materiel Testing Directorate, Aberdeen Proving Ground, Maryland 21005, ATTN: STEAP-MT-I	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Not available
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander, DARCOM, Alexandria, Virginia 22333, ATTN: DRCSF-S	12. REPORT DATE: Feb 1976 / 13. NUMBER OF PAGES: 15 (17p.)
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): None	15. SECURITY CLASS. (of this report): Unclassified / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: None

16. DISTRIBUTION STATEMENT (of this Report)

Distribution limited to U. S. Government Agencies only; Test and Evaluation; February 1976. Other requests for this document must be referred to Commander, US Army Materiel Development and Readiness Command, ATTN: DRCSF-S.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

None

18. SUPPLEMENTARY NOTES

None

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

AR 385-63, recommended changes
Aerial gunnery practice
Aerial gunnery, surface danger zone
Aerial gunnery, towed target
Aerial gunnery, safety interrupt switches

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This Directorate

The Materiel Testing Directorate (MTD), US Army Aberdeen Proving Ground (APG) was responsible for the special study of gunnery practice using targets towed by manned aircraft. The primary objectives were: (1) to recommend changes to AR 385-63 which will allow gunnery practice on targets towed by manned aircraft; and (2) to update the surface danger zone for various ammunition when firing gun air defense systems at aerial and ground targets. The study was conducted at APG from 17 December 1975 to 20 February 1976. The results of

DD FORM 1 JAN 73 1473 A EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

404062

(cont fr 1473A)

20. the study were based upon comments by numerous agencies and the experience of MTD personnel in conducting aerial firing tests of gun air defense systems. Included in the report are: (1) the recommended firing procedures for gunnery practice; (2) updated surface danger zones; (3) a general discussion of firing interrupt switches for the Vulcans, M163 and M167; M42, twin, 40-mm; M45, quad, caliber .50; and (4) a discussion of the safety officer's location which will allow him to determine if a safe firing condition exists. It was recommended that: (1) AR 385-63 be changed immediately to reflect the updated surface danger zone information; (2) a program be initiated for development of standardized firing interrupt switches; (3) a firing interrupt switch be an integral part of any future gun air defense system; and (4) gunnery practice on targets towed by manned aircraft not be allowed until firing interrupt switches are provided.

1473B